Fire and Ecological Disturbance in a Warmer Climate

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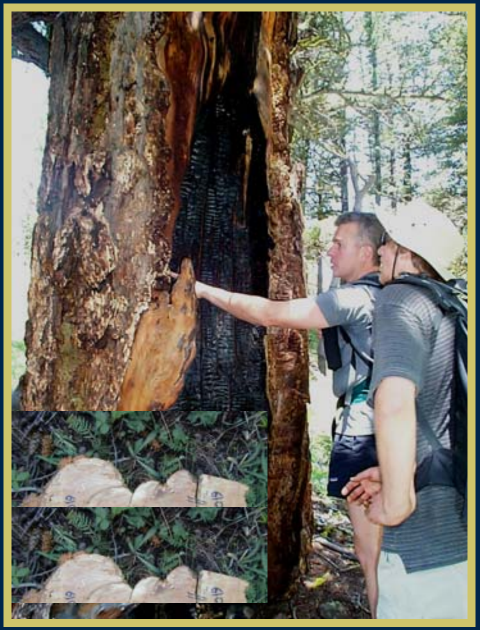
Objectives

- Describe natural fire and forest insect disturbance
- Describe biological and physical mechanisms relating agents of disturbance to climate
- Discuss future disturbance and forest consequences in a warmer climate

Pre-Settlement Fire and Insect Impacts

- We know something about the past influence of insects and fire from paleo-ecology
- Fire and insects have been structuring forests for a very long time
- Now warmer (and warming faster) than any recent period
- Concern?



Ecological Disturbance in Forests

- *Disturbance* is an abrupt change in forest structure as a result of mortality: fire, insects, wind affect patches of trees.
- Varies in impact with type of forest ecosystem
- Different ecosystems are characterized by different types, frequencies, sizes, and severities of disturbance

Hemlock stand prior to looper attack

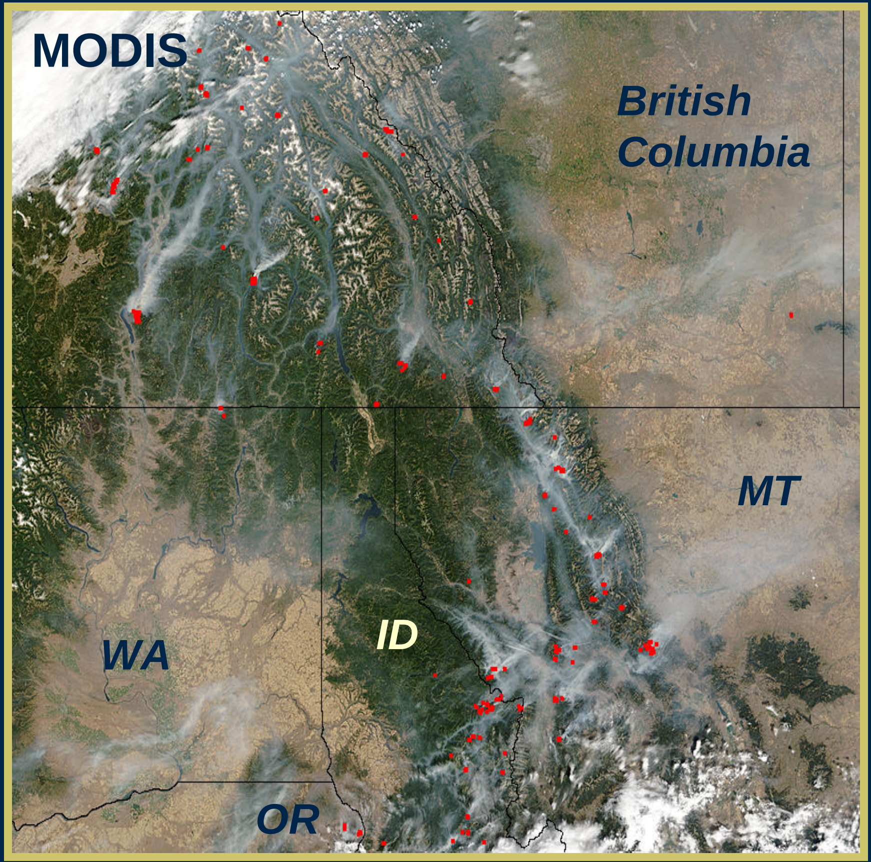
Hemlock looper stand mortality

Fire as a Disturbance in the West

- Some forest types burn infrequently, but often with high mortality for a given fire
- Others burn frequently, but often with less mortality in a given fire
- Both are natural components of forest ecosystems in certain types of forest vegetation

Climate and Fire

- Climate affects the area burned each year by influencing fuel moisture
- High temperature and low precipitation deplete foliar and soil moisture
- Climate often regional, so in severe droughts, larger areas can burn



August, 2003 Northern Rockies Fires

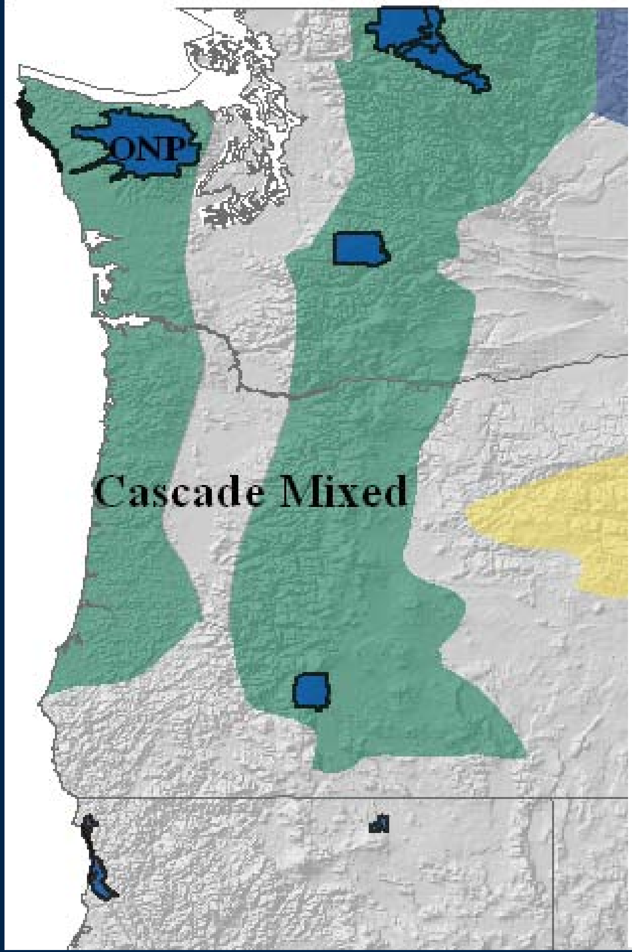
Why Increasing Temperature Can Lead to Increasing Area Burned

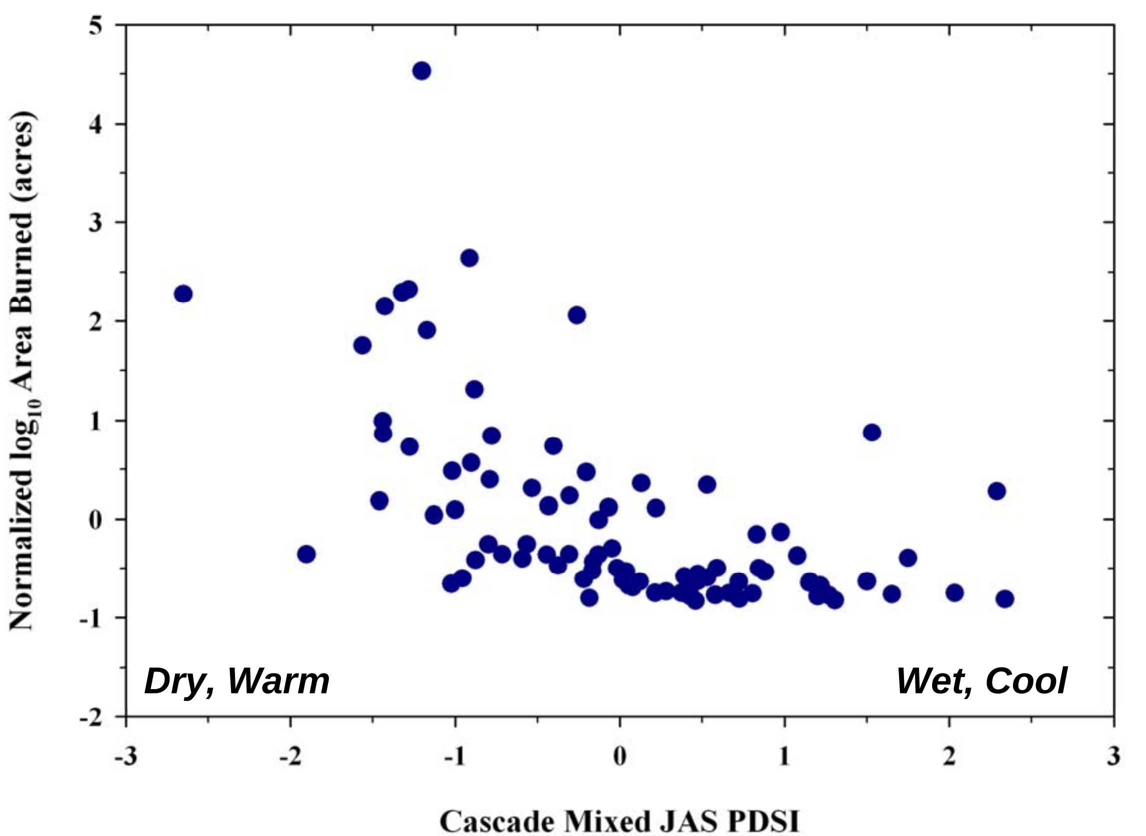
- As temperature increases, the ability of the atmosphere to evaporate water from the landscape and draw water from plant tissues increases

- Climate is often driven by regional-scale (or hemispheric) atmosphere / ocean interactions

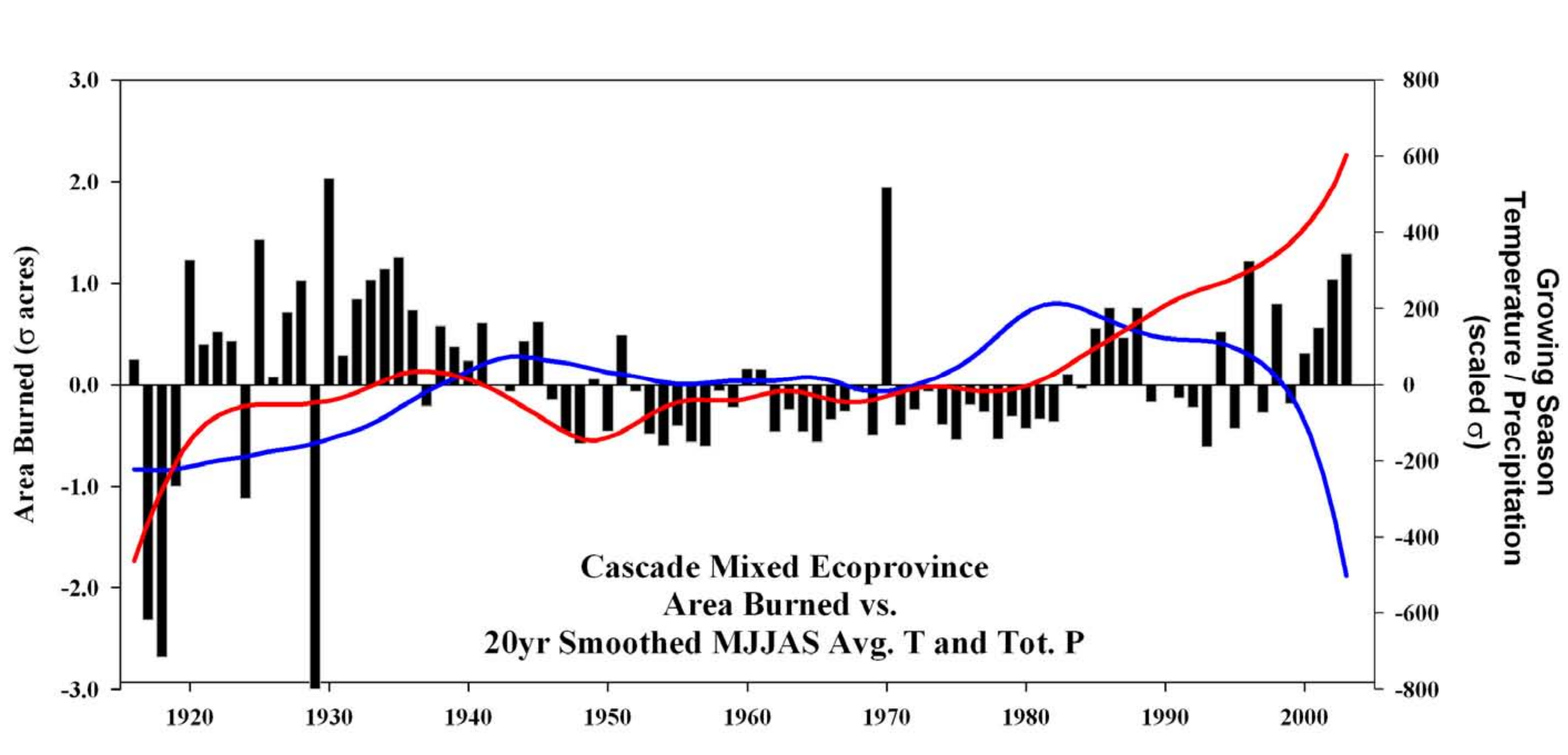
- Large areas can exhibit depleted foliar and fine-fuel moisture during seasons with high temperatures and low precipitation

Fire Area Burned and Drought: A Non-linear Relationship in the 20th Century





Climate and Area Burned:
20th C. Cascade Mixed Eco-province



Insects as a Disturbance in the West

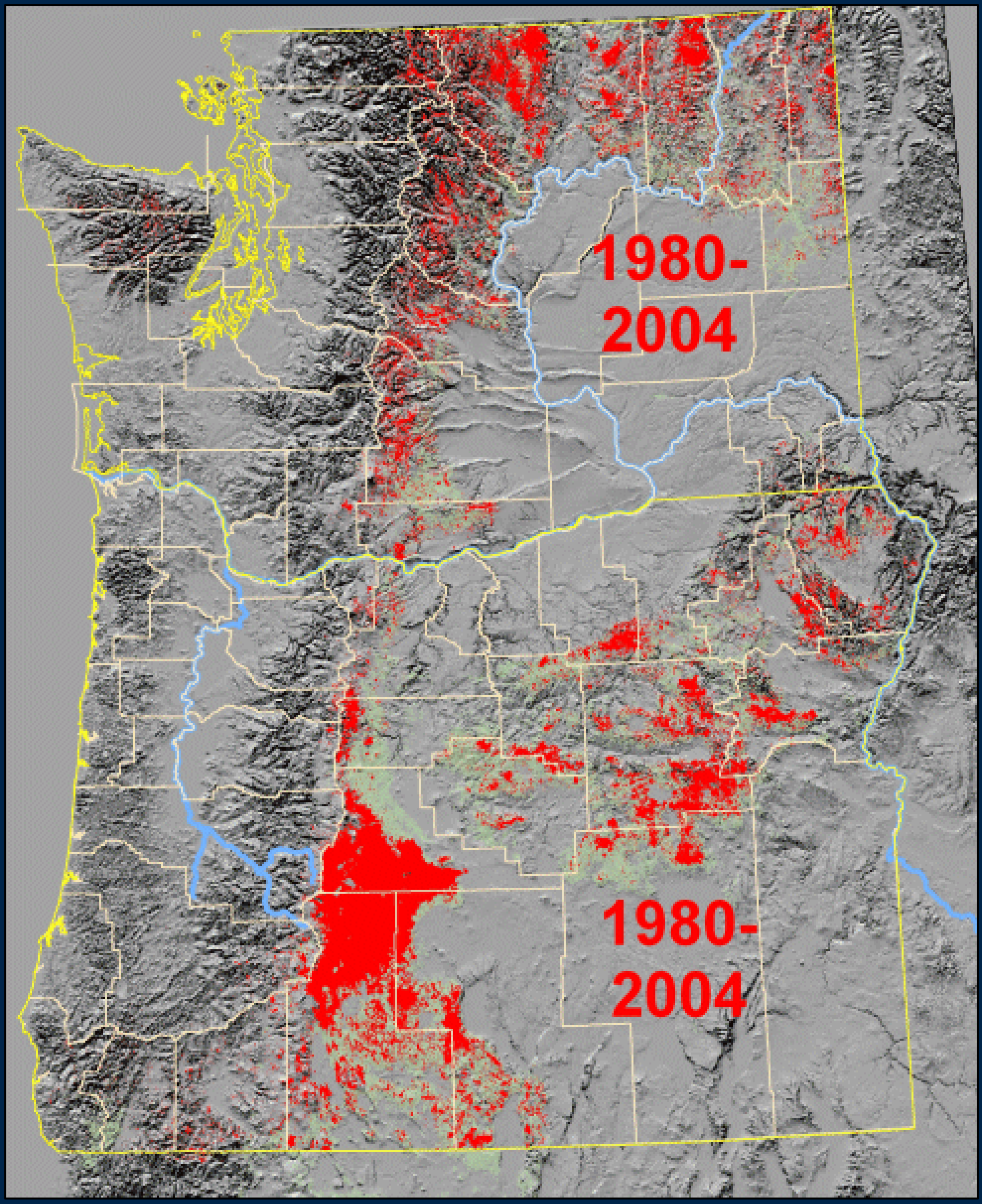
- All forest types have co-adapted with some level of insect disturbance
- Each tree species usually susceptible to at least one species of native bark beetle, budworm, adelgid, or looper
- All are natural components of forest ecosystems; outbreaks are natural
- Exotic species introduced from other ecosystems considered “pests”

Western Hemlock Looper

Mountain Pine Beetle

The Usual Suspects (For Tens of Thousands of Years!!)

- Native insects likely to produce “normative” outbreaks in the PNW:
  - Mountain pine beetle
  - Western pine beetle
  - Spruce beetle
  - Douglas-fir bark beetle
  - Western hemlock looper
  - Ponderosa pine budworm
  - Western spruce budworm
  - Fir engraver
  - Douglas-fir tussock moth
- Exotics: Gypsy Moth



Tree Mortality
caused by
Mountain Pine Beetle
1980 - 2004

Please Note: Shaded areas show locations where trees were killed. Intensity of damage is variable and not all trees in shaded areas are dead. Site-specific information is available at: www.fs.fed.us/r6/nr/fid/data.shtml

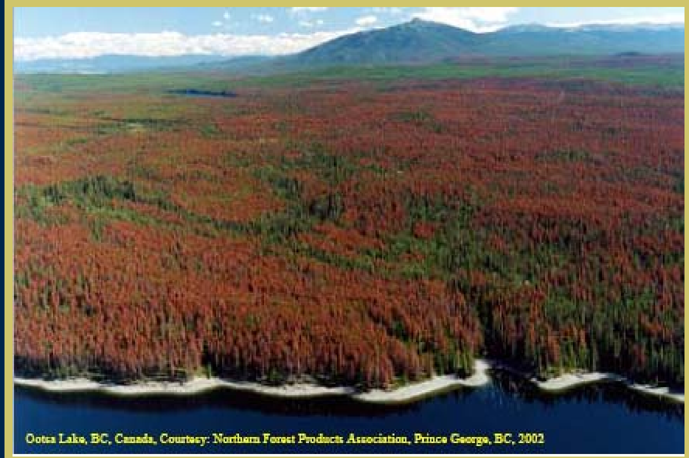
■ = Host Type
Pinus spp.

Sources: Annual aerial insect and disease surveys flown by USDA Forest Service, Oregon Department of Forestry, and Washington Department of Natural Resources; 250m forest type map developed by USDA Forest Service - Remote Sensing Application Center.

Pacific Northwest Region, Natural Resources,
Forest Health Protection

Climate and Insects

- Climate affects the success of insect populations
- Relaxation of previously cooler temperatures increases the number of life cycles possible in a year in high latitude, high altitude environments
- Low precipitation and high temperature increase tree susceptibility to insect attack

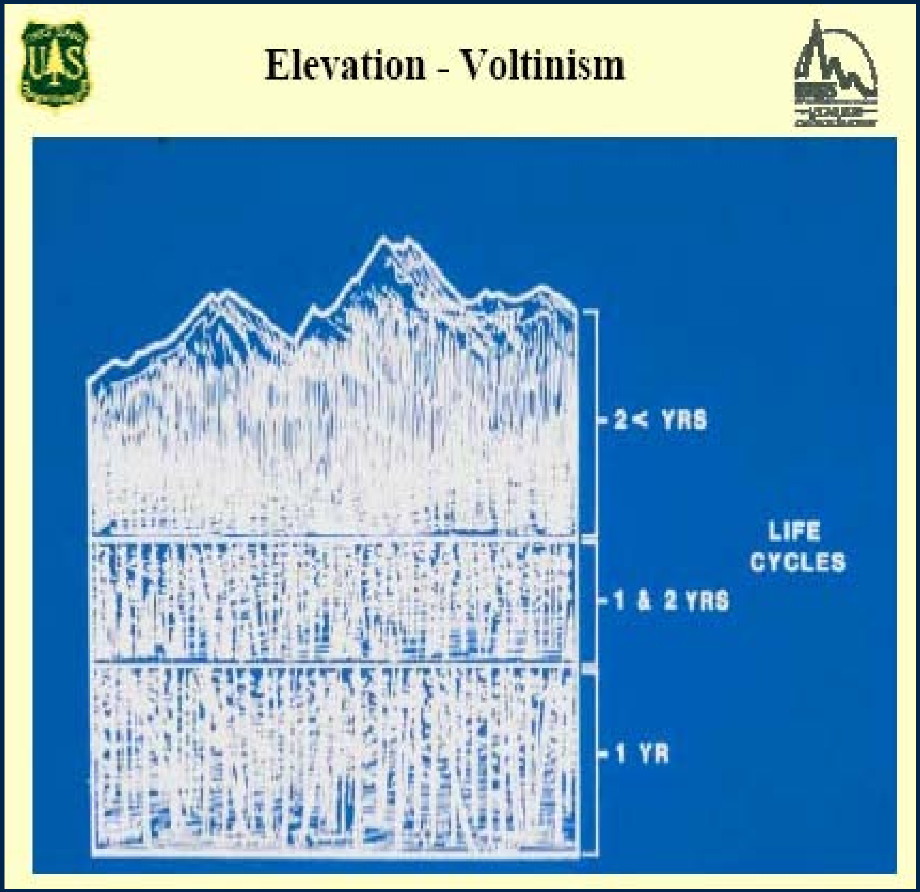


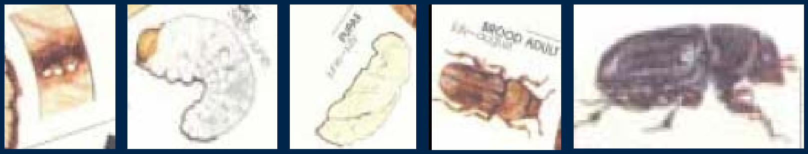
Ootsa Lake, BC, Canada, Courtesy: Northern Forest Products Association, Prince George, BC, 2002

Glacier NP, USA, late 1970s

Why Temperature Increase Releases Mountain Pine Beetle Populations

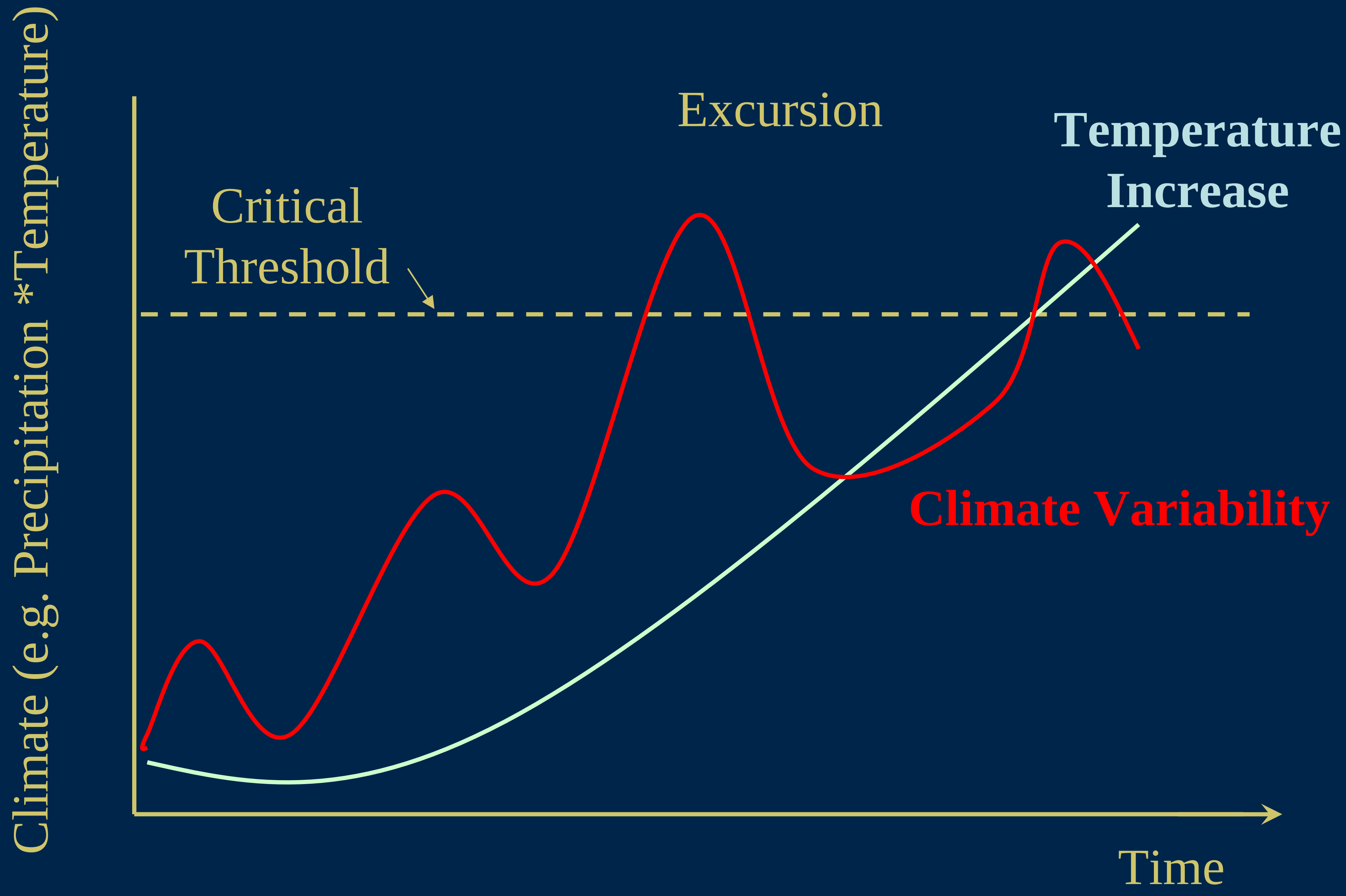
- Population synchronized by temperature
- Rate of generation turnover decreases with temperature increase
- Mountains were a barrier until recently



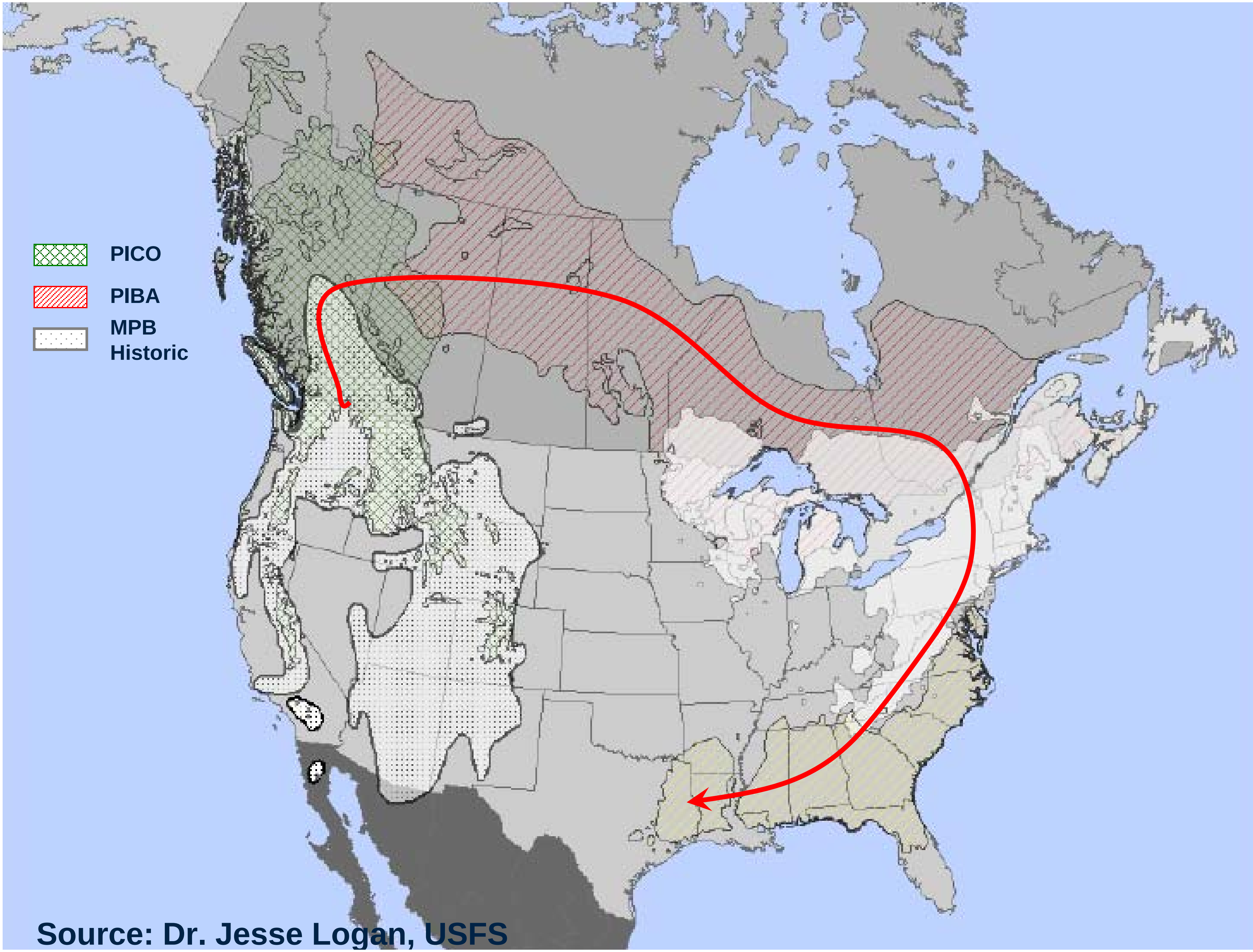


Figures courtesy Jesse Logan

Thresholds are Important

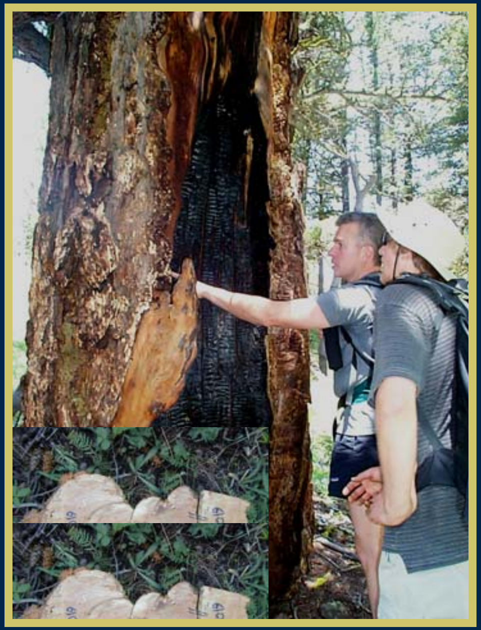


After Gray, unpublished


PICO
PIBA
MPB
Historic
Source: Dr. Jesse Logan, USFS

Insects and Fire

- Fire can increase vulnerability of surviving trees to insect attack
- Stands successfully attacked have short-term increases in fire-available fine fuels
- When increases in fire area burned and insect population increases are both nonlinear, the rate of ecosystem change can proceed at a level we haven't observed

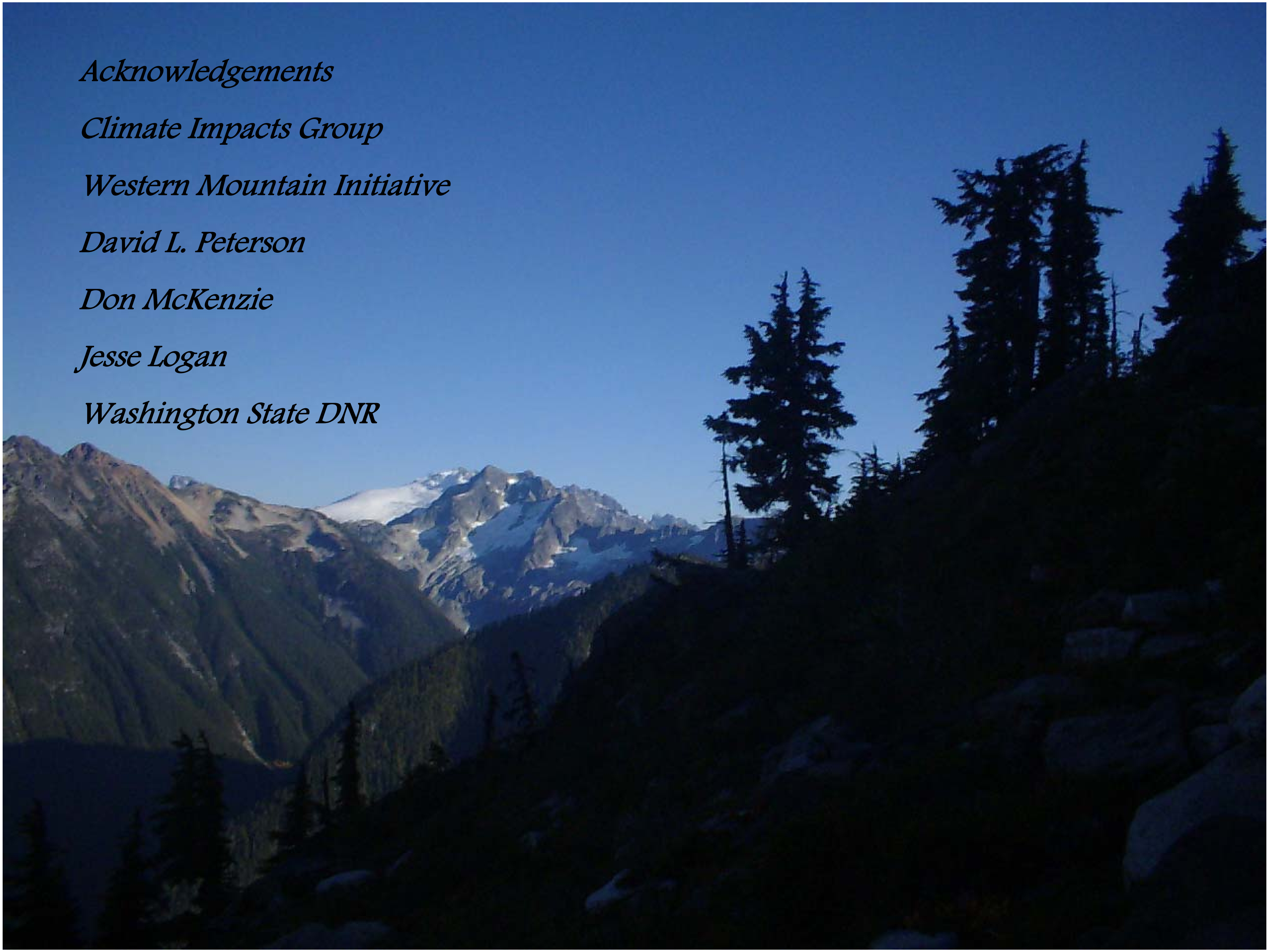


What Can We Expect?

- **Short term (1-2 decades):**
  - Increasing area burned
  - Increases in area of insect mortality
- **Mid term (2-5 decades):**
  - Shifts in fire frequency; adaptation of forests to insect mortality from native species, but exotics….?
  - Wild-card (insects, fire, or both) becomes the driving agent of what management adaptation is possible
- **Long term (3-?? decades):**
  - Changes in the probability of recruitment by previously present tree species given past fire and insect disturbance

What Can We Do?

- **Short term (1-2 decades):**
  - Monitor, experiment, monitor, learn: adaptive management in the urban interface
  - Leave old forests, which are usually most resistant
  - Use younger forests to experiment in; they're the most vulnerable and they give more options to managers
  - Focus on making vulnerable ecological economies into adaptable, resilient systems
- **Mid term (2-5 decades):**
  - Use monitoring to determine when other tree species may be more appropriate
  - Think long term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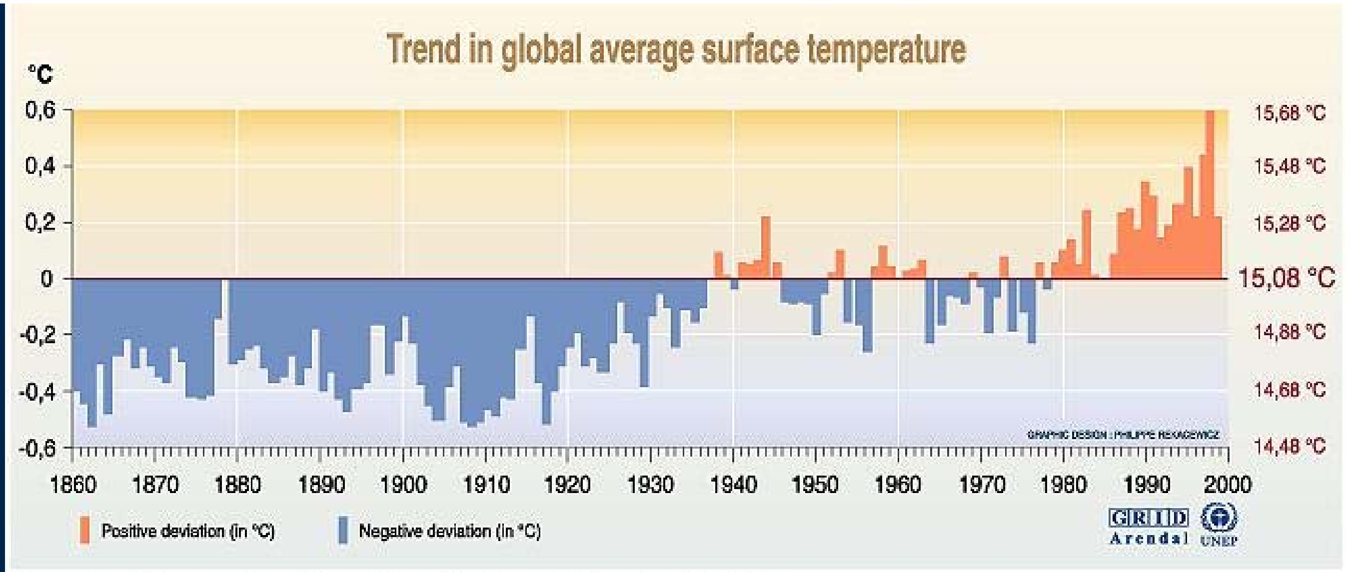

Source: School of environmental sciences, climatic research unit, university of East Anglia, Norwich, United Kingdom, 1999.

MEDIUM-RANGE TASKS: ANTICIPATE CLIMATE CONTROLS	LONG-TERM STRATEGIES: ADAPT TO NATURAL CONSTRAINTS
Goal: *Shift institutional decision-making process from reactionary to adaptive*	*Goal:* *Maximize adaptability, minimize vulnerability to climate change*
Define the role of fire consistently with its climatological and ecological constraints	**Tailor hazard-reduction actions to likely timing of interannual climate variability**: ecological precautionary principle
Abandon blanket view of fire: causes and consequences of fire are not the same in all places at all times	**Increase resilience to climate variability** by prioritizing restoration in the most fire-adapted ecosystems
Abandon current definitions of solely economic **sustainability** in favor of economic and ecological resilience	**Emphasize adaptation** in wildland-urban interface as a likely success story
Adopt regionally-specific understanding of climate-impacts for anticipating fire events and fire regimes	Continue to **revisit policy** in light of new climate information, fire information, and new socioeconomic or legal contexts